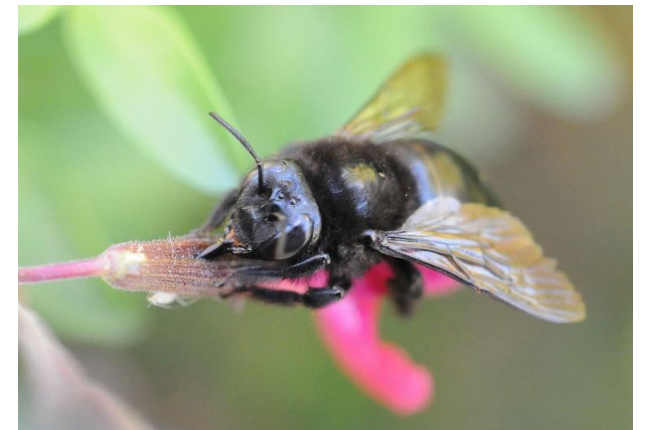




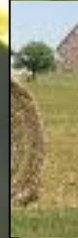
Pollinators in agriculture, alternatives to European honey bee, habitat enhancement

Neal M Williams - University of California Davis



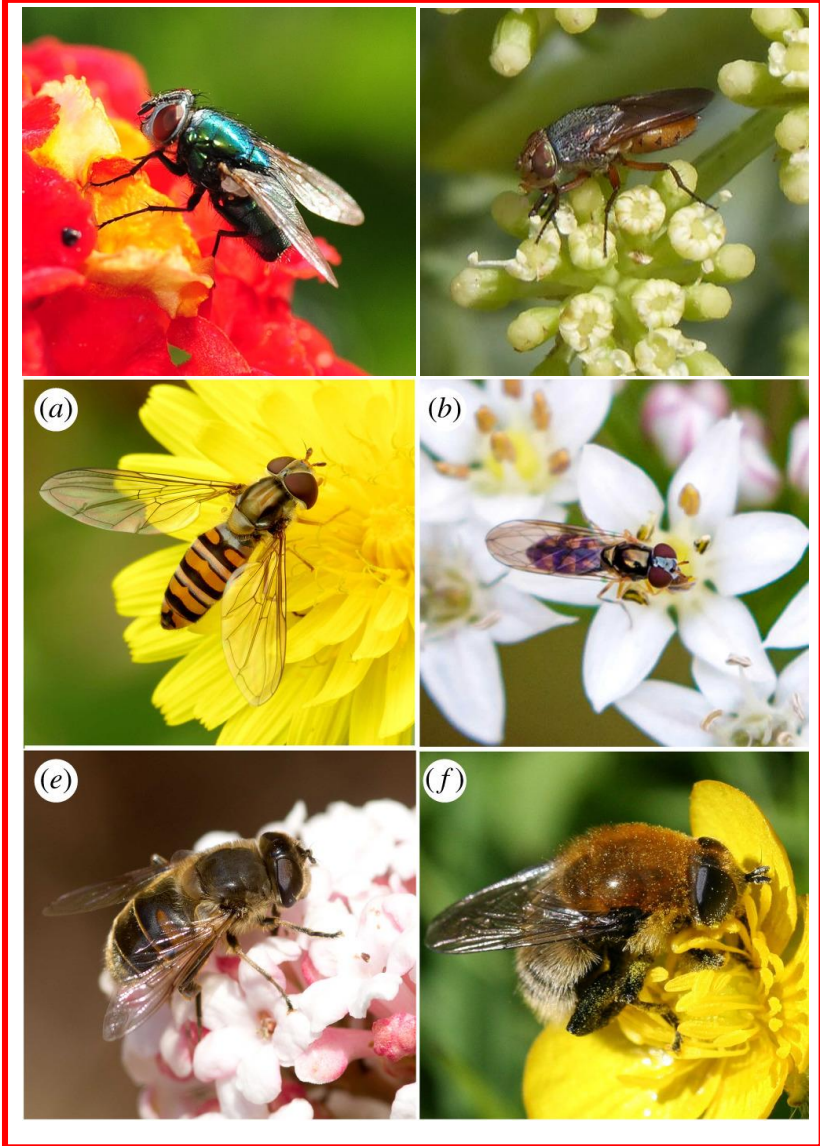
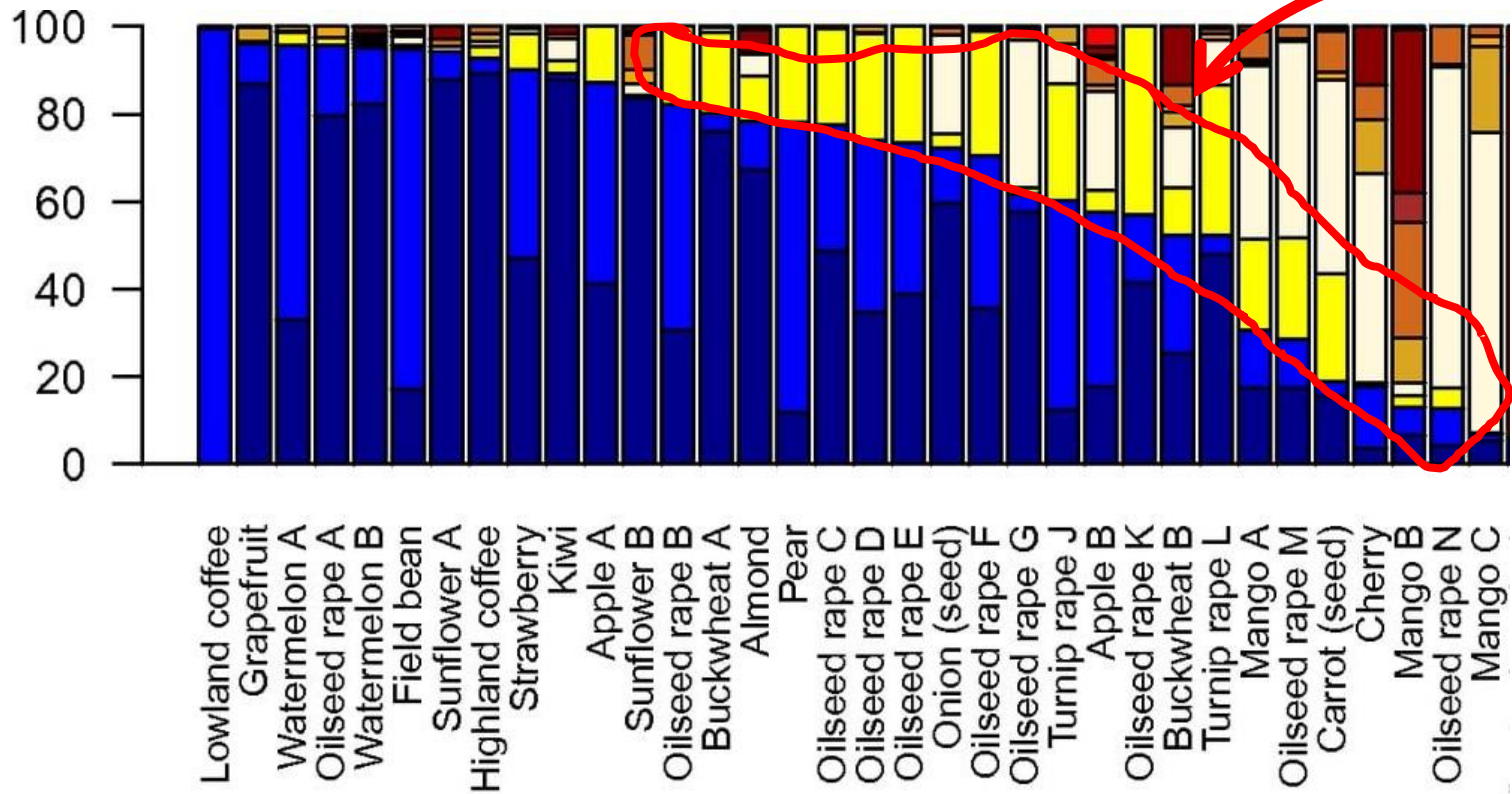
Managed pollinators

Native pollinators



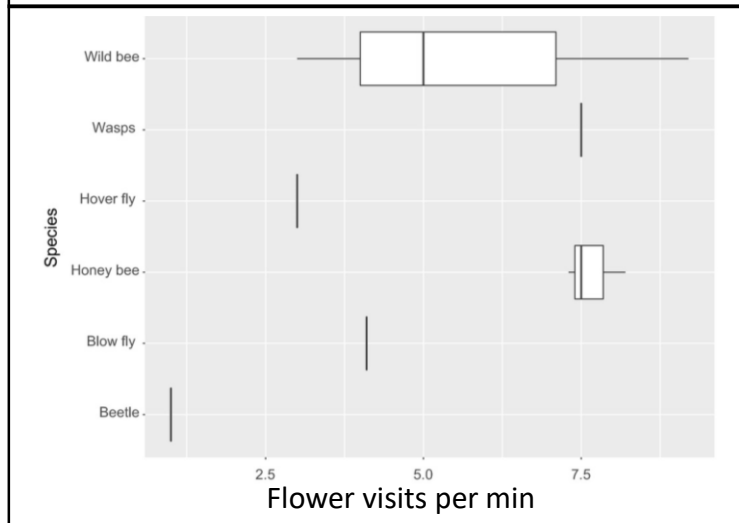
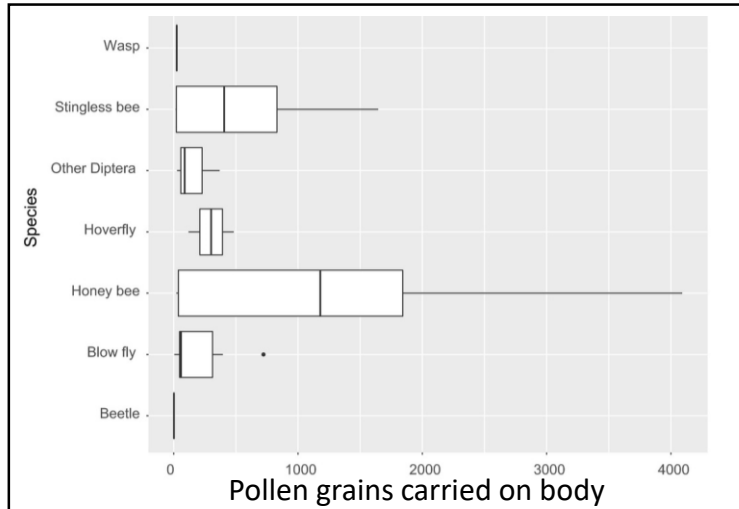
Potential role of flies

% visits of insect groups

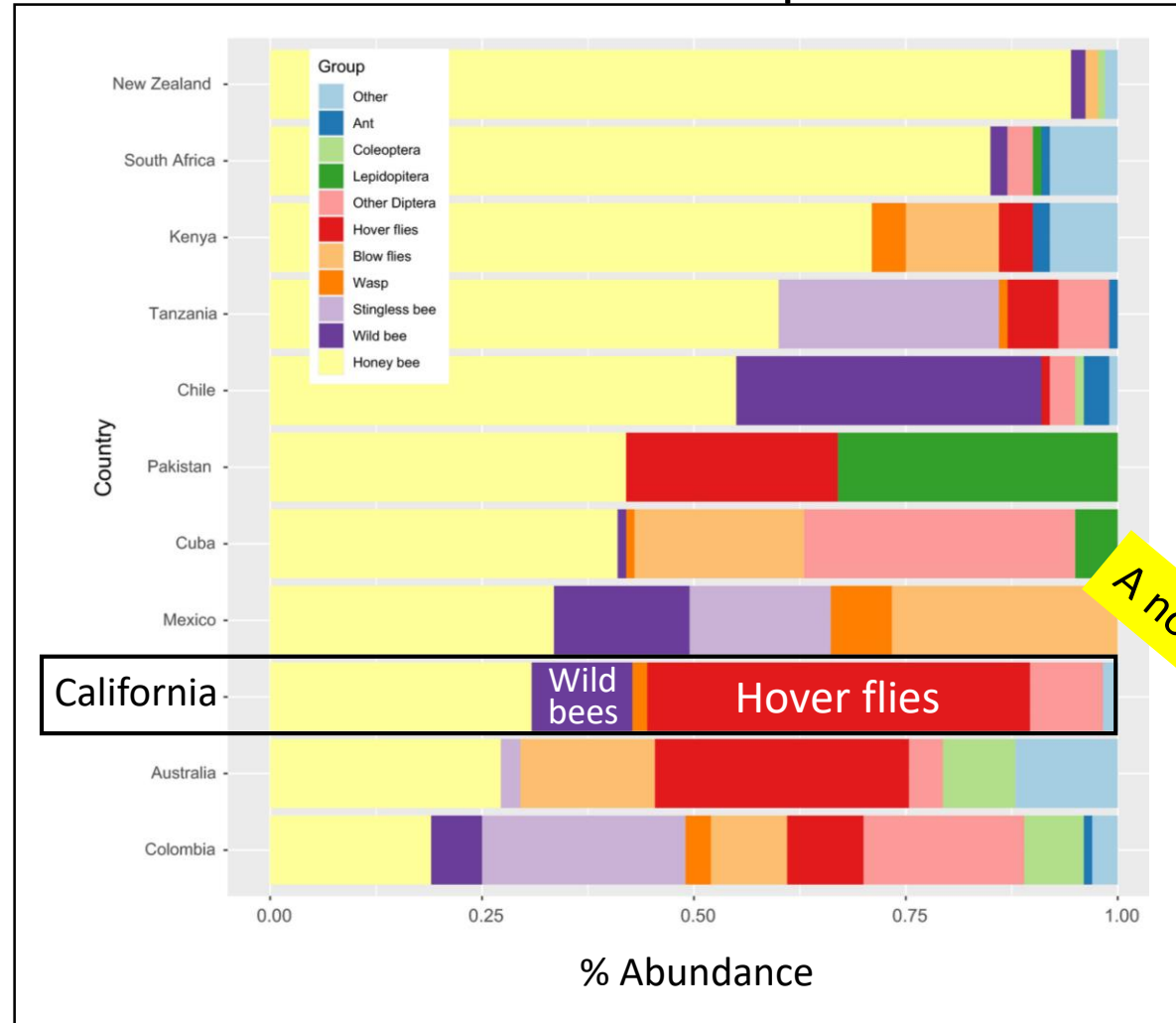


Pollinators and avocado

Effectiveness estimates



Flower visitor composition



A note about wind

High bee diversity in California

**1600 +
species**



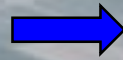
Irony of intensive agriculture and pollination

An aerial photograph showing a vast agricultural landscape. The land is divided into numerous rectangular and irregular plots of various colors, including shades of green, brown, and tan, indicating different crops or stages of growth. A prominent, winding river or canal cuts through the landscape, curving from the upper right towards the lower right. The overall scene illustrates the fragmentation of natural habitats by intensive farming.

- Areas of great pollination demand
- Intensive agriculture challenges bees
 - Pesticides (mortality and physiological stress)
 - Forage (flowering plants)
 - Nutrition (diverse pollen and nectar)

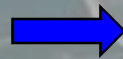
Reduced habitat / forage for bees

- Removal of native habitat
- “Clean farming” removal of weeds
- Larger field sizes



Decreased non-cropped vegetation

- Local and regional consolidation of crops



Loss of spatial and temporal flowering diversity

Wild bees can persist where their resource needs are met

Honey bees benefit from diverse, high quality forage

Planting habitat for pollinators

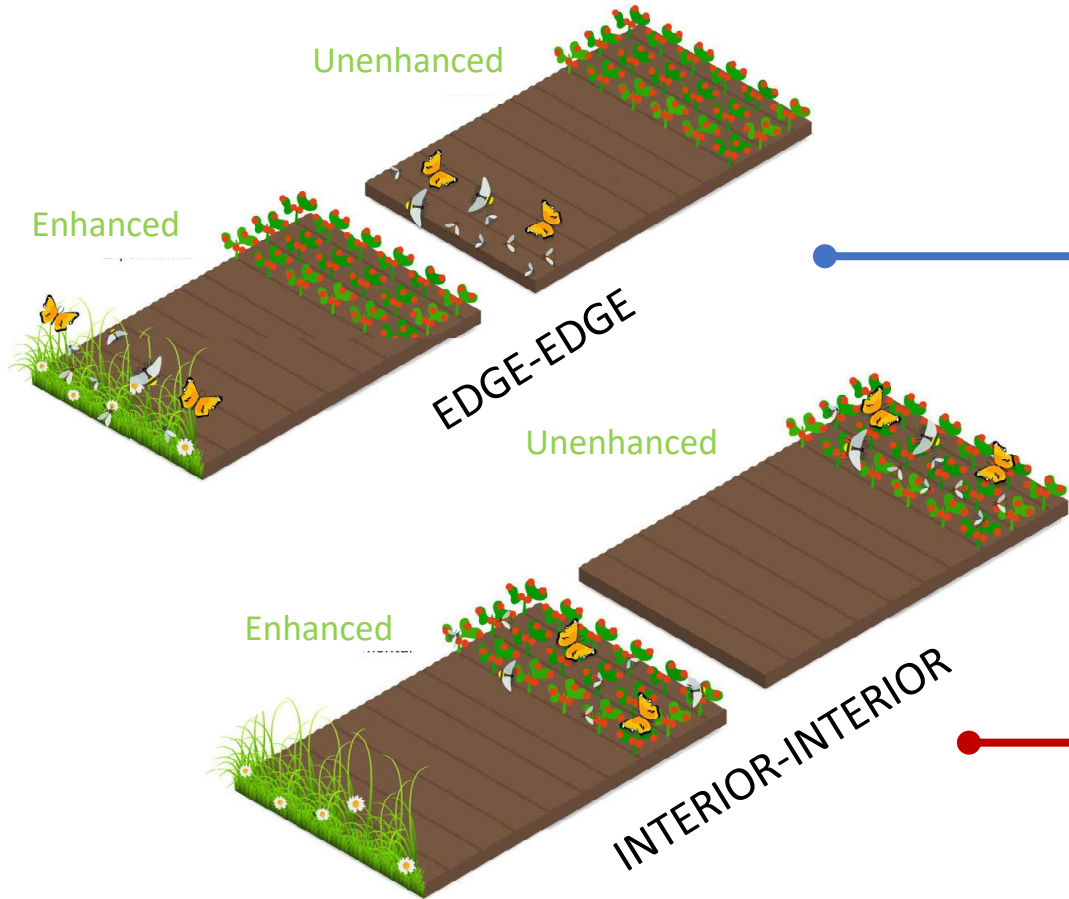
Dual goals of habitat enhancement

Biodiversity: Support forage habitat for diverse wild and managed bee populations

Pollination: Enhance pollination services to crops in agricultural landscapes



Neighboring habitat benefit biodiversity but not necessarily pollination



Comparison of enhanced edges with controlled edge show consistent benefit to pollinator diversity and abundance in these habitats.

Comparison of crop visitation and yield next to enhanced edges versus controlled edges show inconsistent to pollinator visits and yield.

Work from Central Valley .

- Do proposed wildflower mixes and the resulting habitat plantings function in real landscapes?
1. Improve support for **biodiversity of wild bees**
 2. Increase **pollination of adjacent crops**



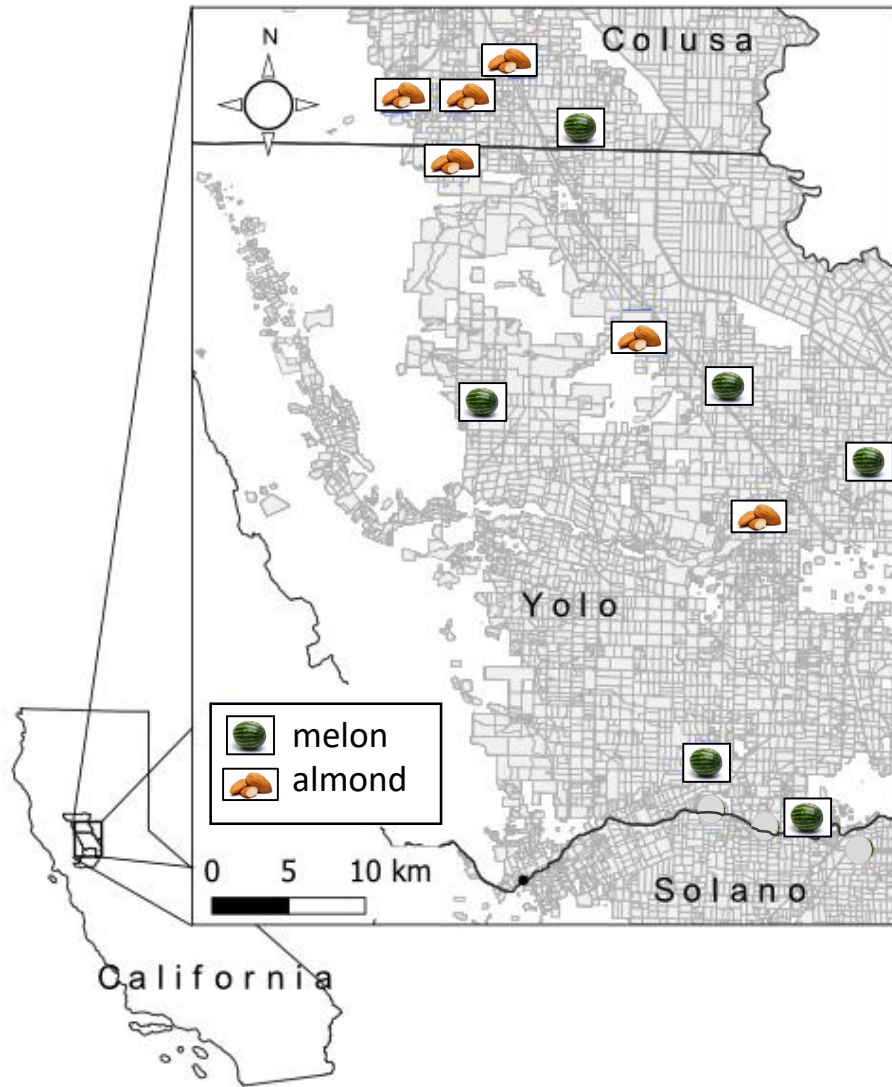
Research design



• 2 years, 12 sites



• 3 years, 10 sites



Research design



Border Biodiversity sampling - season long

- Flowers
 - Planted species and “weedy species”
- Insects
 - Bees netted from flowers along transects

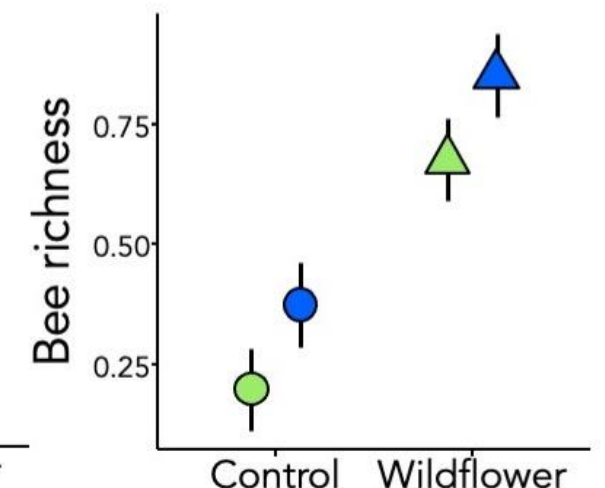
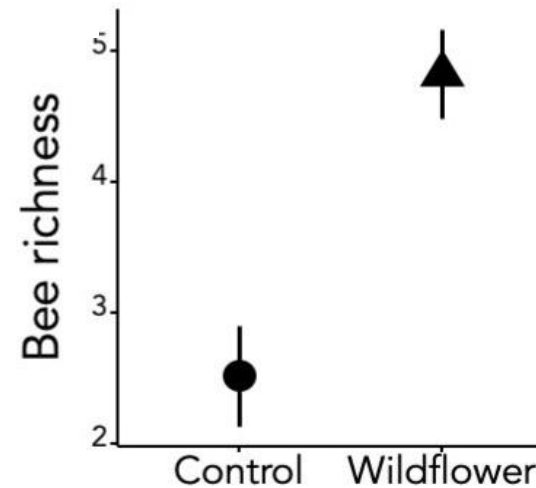
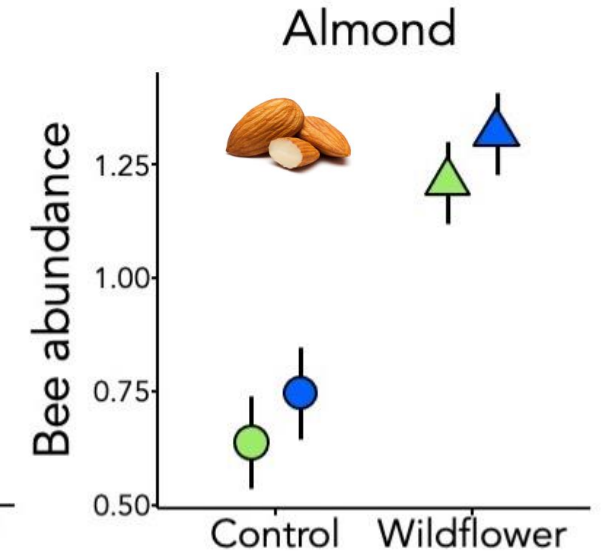
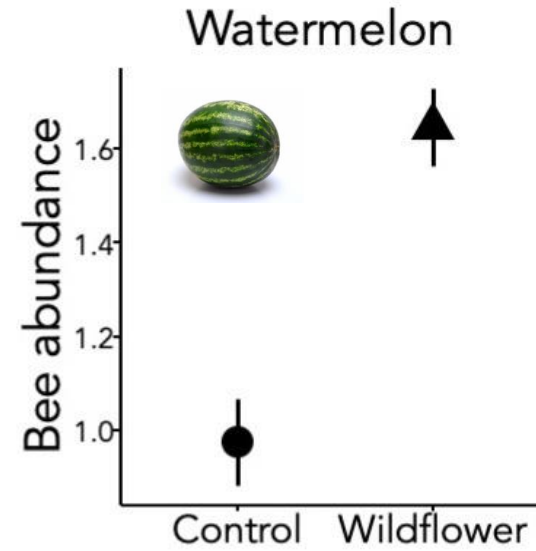
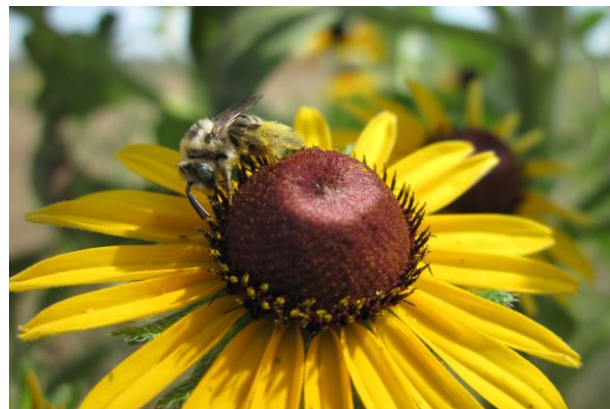


Crop visitation and yield

- Watermelon
 - Assess fruit density, fruit mass
- Almond
 - Nut set

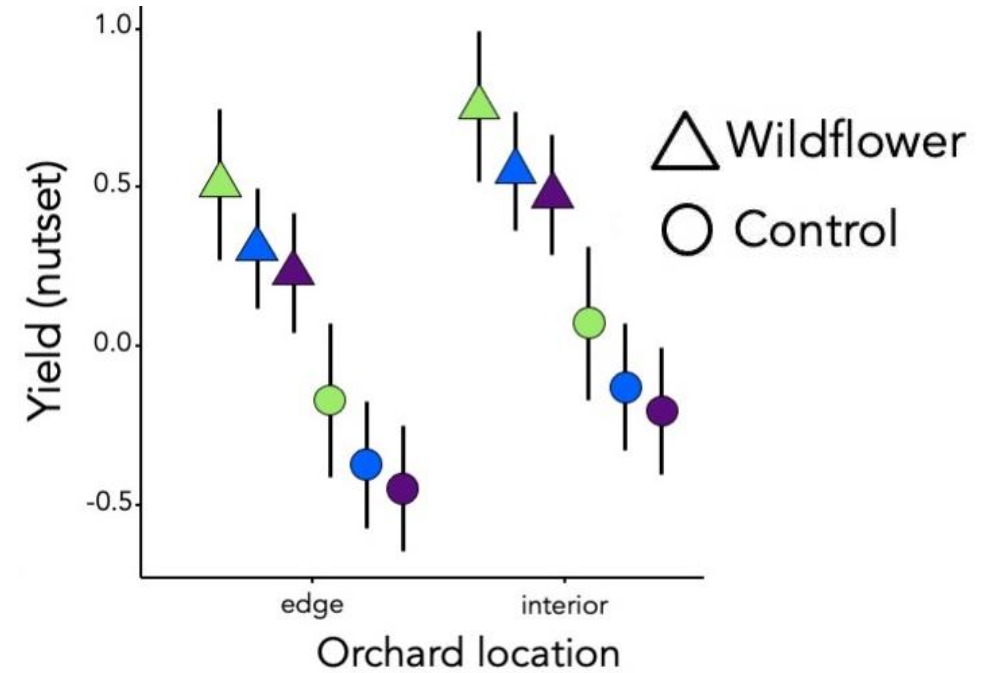
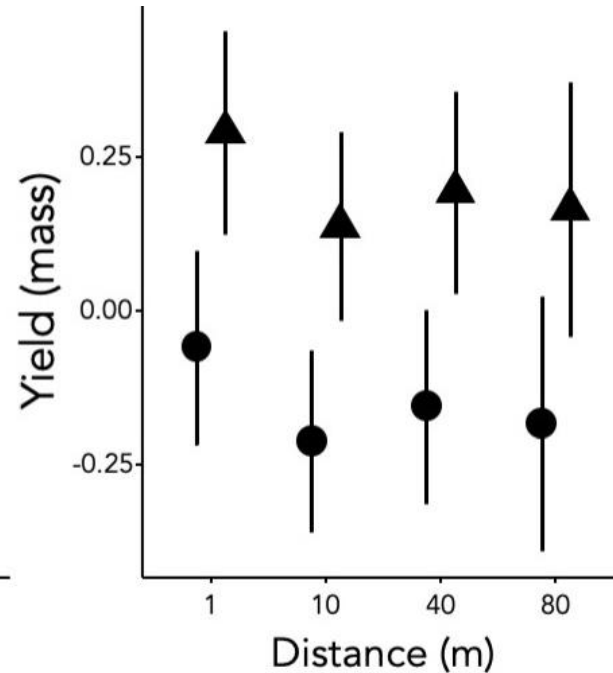
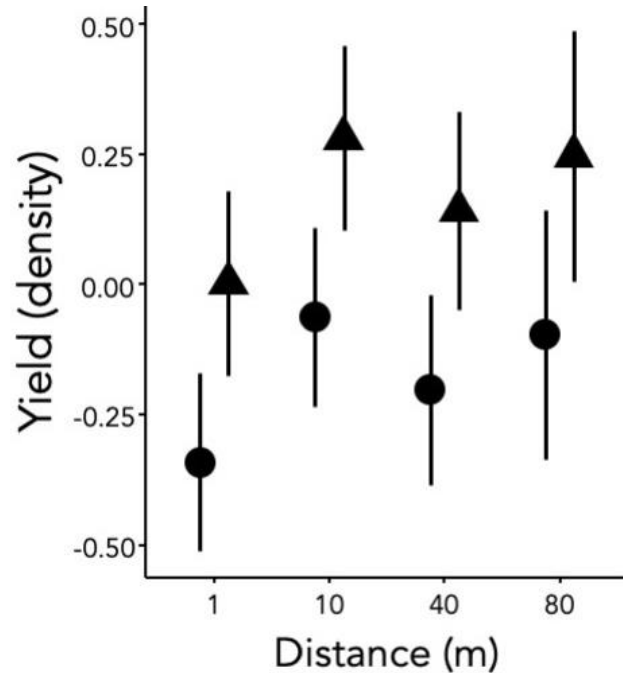
Results: Biodiversity value

Wildflower planting support more abundant and diverse bee communities



Results: Ecosystem service value

Wildflower planting increased pollination and crop yield in both systems



Habitat is more than simply flowers: bee nests

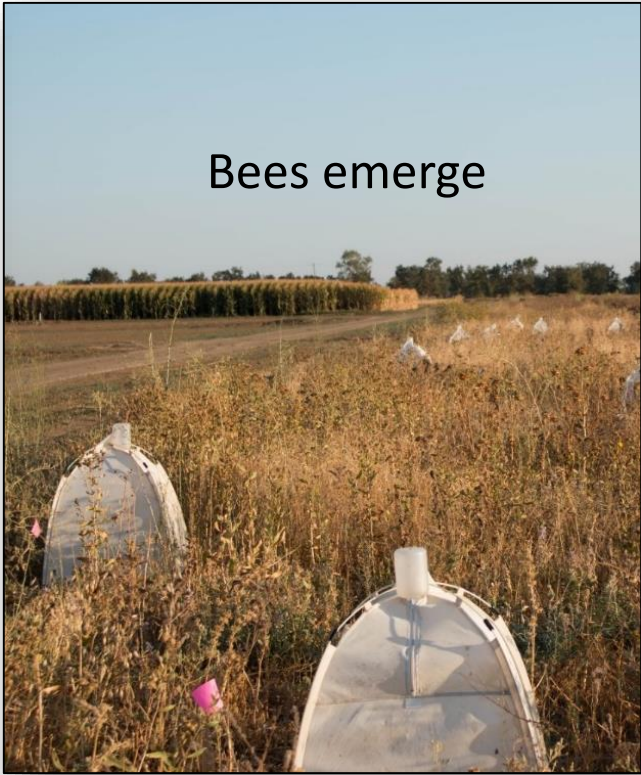


Nest densities on wildflower and control borders

Day 1 PM



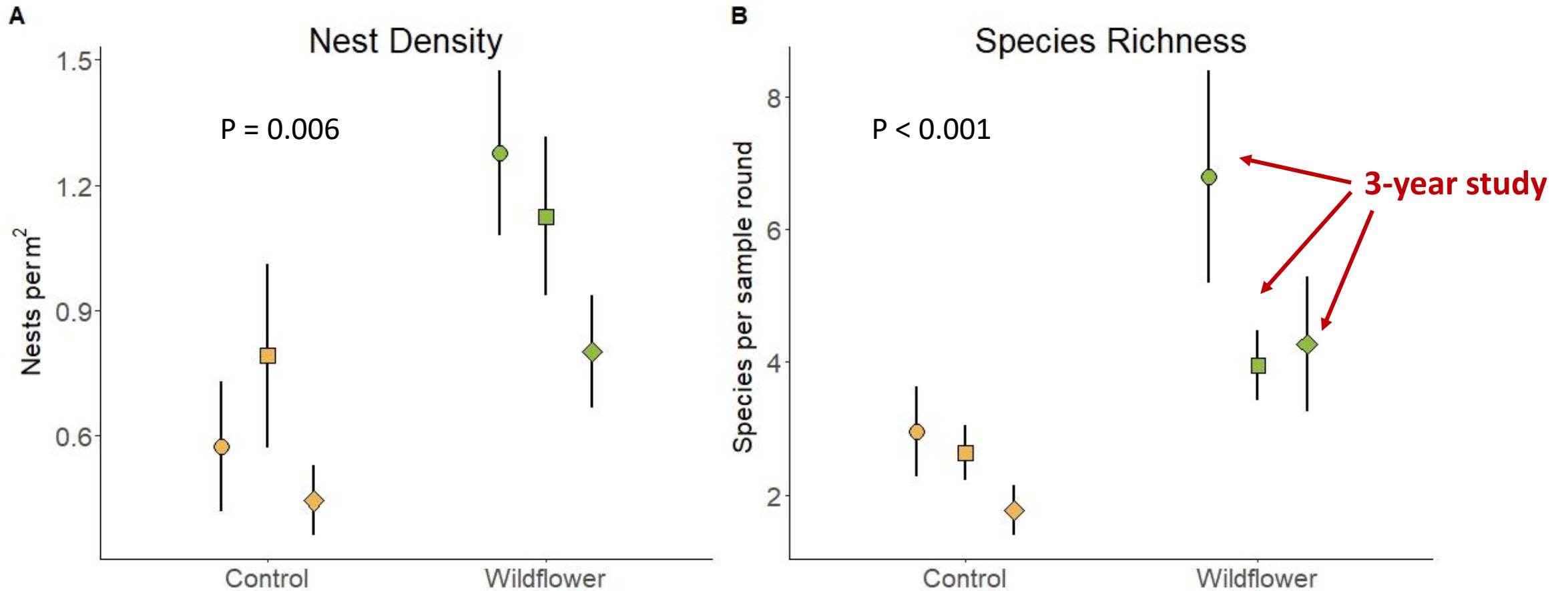
Day 2 AM



Day 2 PM



Wildflower borders enhance nesting for bees



- Nest density and bee richness were significantly higher on wildflower borders

Role of natural habitat and habitat enhancement for avocado

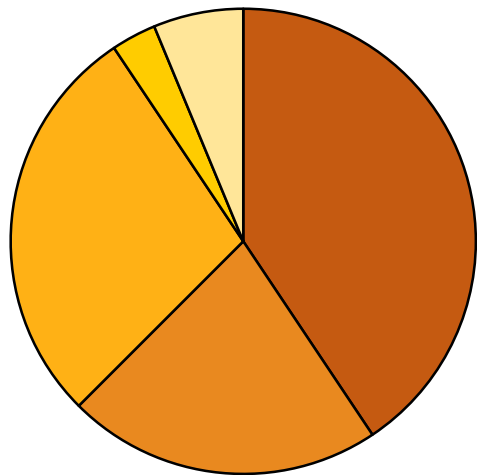
- Does it benefit avocado pollination?
- Which insects are most effective pollinators of avocado?
- Benefit to diversity?
 - Gordon Frankie, Ben Faber
 - Liz Scordato, Adam Lambert



Diversity of insect visitors to avocado flowers in Ventura-Santa Barbara region

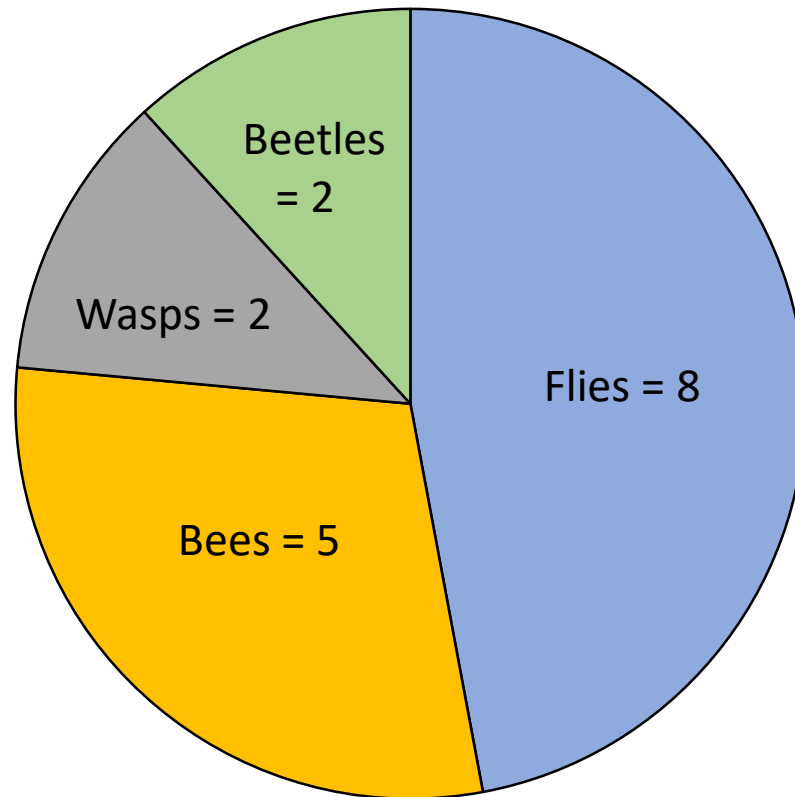
Families per Insect Order

- Halictidae
- Andrenidae
- Apidae
- Colletidae
- Megachilidae

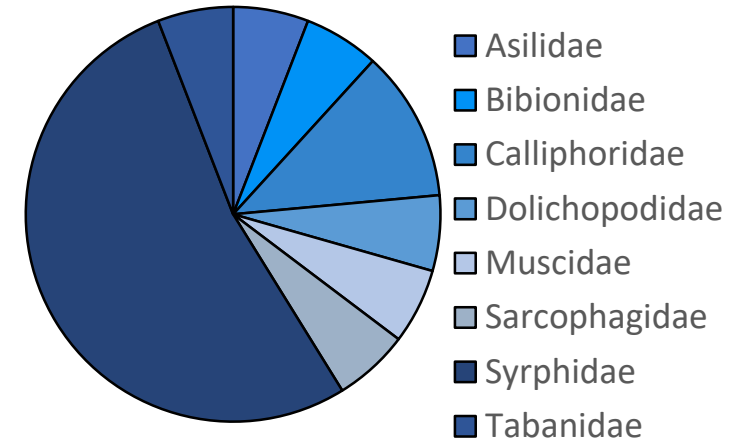


35 total

Bee Species per Family



Fly Species per Family



17 total

Research team



Hamutahl Cohen



Ben Faber



Gordon Frankie



Arnon Dag



Yael Mandelik

- Coordinating with Cal Poly Pomona and UC Santa Barbara

Extras

- Pollination system in Avocado
- Controversy about need for insect pollination based on Davenport work?
- That study as you are aware was local for CA and seems to suggest wind not insects are key and that self not outcross pollination is also central